Occupational Outlook Quarterly

In this issue:

How Automation Will Affect Office Workers
Employment Outlook for Biological Scientists
Military Training and Civilian Jobs

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September 1958

UNITED STATES DEPARTMENT OF LABOR
Bureau of Labor Statistics
in cooperation with
VETERANS ADMINISTRATION

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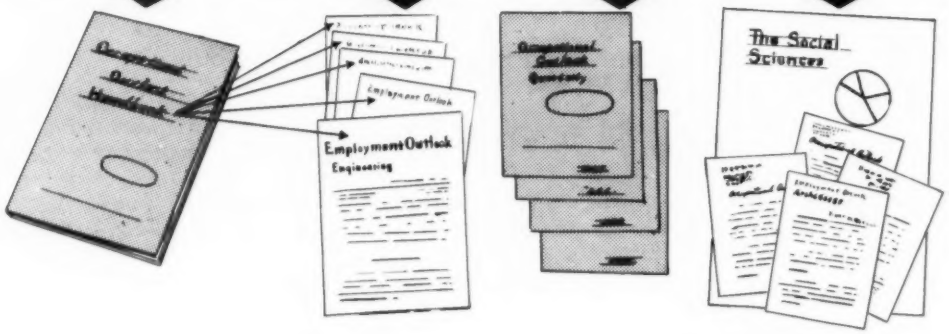

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HOW AUTOMATION WILL AFFECT OFFICEWORKERS*

by William Paschell
and
Daniel P. Willis, Jr.

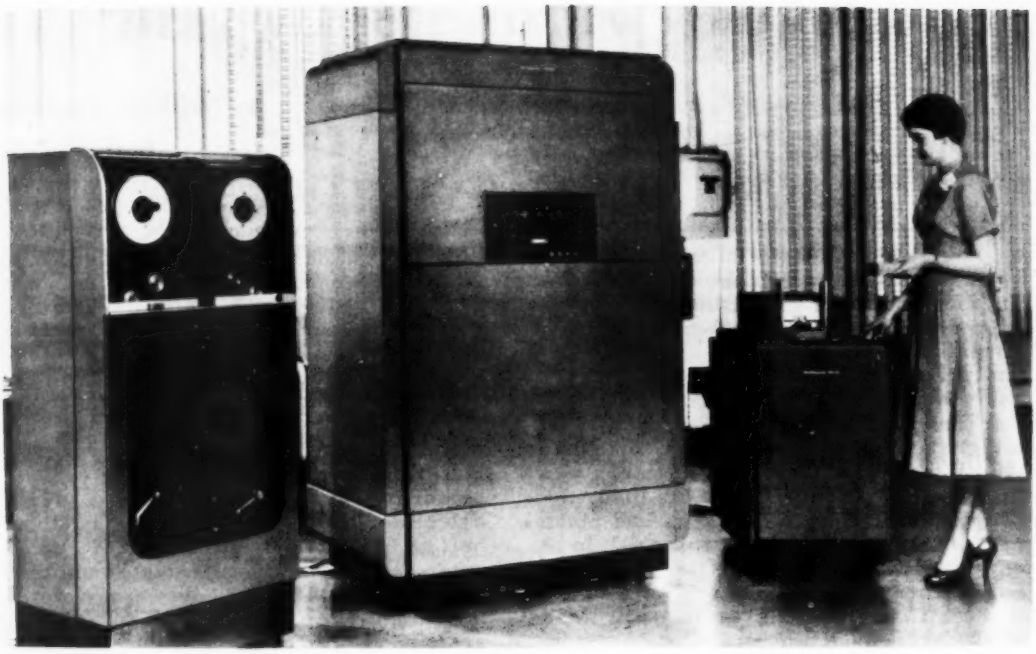
A great force of clerical workers --more than 9 million in mid-1958--is employed to take care of the vast amount of recordkeeping and other paperwork essential to the operation of government and private business. Clerical workers represented about 1 out of every 7 workers in the United States in 1958, a higher proportion than in any previous year. In 1910, only 1 in 20 workers was in a clerical occupation. By 1940, the proportion of clerical workers had risen to 1 in 10, and in 1950, it was 1 in 8 employed workers. Since then, clerical employment has grown more slowly, but it is still increasing faster than the work force as a whole.

The rapid rise in clerical employment reflects the ever increasing volume and complexity of the clerical work handled by the Nation's expanding industries and by government agencies. In this work, clerical employees have for many years used typewriters and a variety of other machines, including adding, calculating, bookkeeping, billing, and duplicating machines. More recently, many large offices have installed punch-card equipment--machines by which data are recorded on cards by punching holes in them, and which then sort the cards and tabulate and print the data from them. Despite these advances, the number of officeworkers has continued to climb, and employers are constantly looking for new and improved machines to handle the ever growing workload.

In the last few years, attention has focused on a new development in office machines--the use of electronic computers to handle tremendous amounts of data. Electronic computers have attracted great interest because of their capacity to perform millions of computations--adding, subtracting, dividing, and multiplying--automatically and with lightning speed. At a government installation, it was estimated recently that it would take one person a year to perform computations on a desk calculator that could be done in about half an hour by a large electronic computer. When a computer is assembled in a unit with various types of related equipment, an electronic data-processing system is formed. Such a system consists of a central computer and "peripheral" equipment including converters which transfer information from punched cards to magnetic tape (or the reverse operation); readers that make the instructions on the tape or cards usable by the computer; and printers that record the final results in a form that can be read. A computer system can automatically do such jobs as prepare payrolls for thousands of employees, control inventory on a multitude of items, or produce speedy results from masses of statistics concerning the entire population of the United States.

Although computers are often described as machines that can "think," this is, of course, not so. Like other machines, they must be operated or controlled by people who start them, feed work into them, make certain they work properly, remove the completed work, and otherwise tend them. Computers are useless unless they are given the proper instructions for performing the many computations necessary for the final result. The people who prepare the instructions are called programmers. Other workers are also needed to aid in preparing the work

*This article supplements the information on clerical workers given in the 1957 Occupational Outlook Handbook. The article is based on a study conducted by the Bureau of Labor Statistics in cooperation with the Veterans Administration. The complete report on the study will be published as a Bureau of Labor Statistics bulletin in the near future.



Operator placing punched cards in a card-to-tape converter

for the machines. This article discusses the implications of automation for employment both in these new jobs and in other kinds of office work.

Development of Office Automation

Electronic computers were developed during World War II as an aid for solving intricate scientific and engineering problems such as gunfire control, but their application to the processing of office data is more recent. The Federal Government led the way in 1951, when an electronic computer was installed by the Bureau of the Census to help compile the statistics of the 1950 Census of Population. The first computer installation in a business firm was completed in 1954. Since then, the installation of computers and related equipment has proceeded rapidly. It is estimated that more than 800 medium-scale and 200 large-scale electronic computer systems had been installed by early 1958. At that time, the average medium-scale system cost about $250,000 or rented for $7,500 a month; a large-scale system cost more than a million dollars or rented for at least $25,000 a month.

Uses of Computers

Computers can be used to perform many of the accounting and related functions commonly required in large businesses. Electric, gas, and telephone companies, for example, are using computers to make up monthly bills for many thousands of customers; the computing system does the complete job of printing the customer's name and address on a bill, listing each item, figuring the cost, adding taxes and other necessary items, and then adding the total bill. Payroll work, including computation of the amounts to be paid and the printing of paychecks for thousands of employees, is a common application of the computer. In large insurance

operations, the machines may be used to prepare notices of premiums due, compute dividends, calculate agents' commissions, make the millions of computations used in actuarial departments, and prepare statistical tables. Some business firms and government agencies use computers in inventory control so that they may know at any time the supply of items of each type in several warehouses or other outlets. Computers are also used to help employers plan for the future--for example, in analyzing the market for goods, forecasting sales, and estimating production requirements.

Some computing systems are built to do a specific job. A central computer, for instance, installed by an airline or hotel chain, stores information gathered from many locations, and enables a clerk in one city to answer travelers' questions about available reservations in a matter of seconds. In firms doing a nationwide business, a computer can be linked with special communications equipment so that a sales order may be simultaneously punched on paper tape in a company branch office and in the main office; the tape may then be processed by the computer equipment to prepare an up-to-the-minute sales or inventory report at about the same time the order is being filled in a company warehouse.

In government offices, computers may be used in large-scale statistical operations or in preparing research and other special reports. The tremendous clerical operation of keeping records for the millions of workers covered by Federal social security and of digesting masses of data collected by the Census Bureau on the population of the United States are areas where computers are especially helpful. A computing system in one State keeps up-to-date records for nearly 5 million automobile drivers--by name, address, date of birth, sex, and driving record --and even determines fines for traffic violations.

In scientific and engineering fields, computers are used in solving problems

Console operators of electronic computers need specialized training

such as those relating to launching and tracking earth satellites, forecasting weather, simulating oil refinery processes, and controlling the operation of industrial machine tools (sometimes called numerical control). Since these applications involve the employment of relatively few clerical workers, they are not as important for the purposes of this article as the use of computers to process masses of office data.

New Occupations Related to Office Automation

The use of electronic computing systems has created a number of new office occupations and has changed the functions performed in others. Some of the new jobs, especially those in programming require considerable related experience or education at the college level. Many of the other jobs related to the operation of computing systems also require higher levels of skill and training than are needed for most other types of clerical work. In general, high school graduation is the minimum educational requirement.

The following is a brief listing and description of jobs which may be found in companies with large-scale electronic data-processing equipment:

Project planner--Plans and administers the installation of a data-processing system.

Systems analyst--Devises broad outline of plan to program an operation.

Programmer--Writes the detailed instructions or program used to guide the machine system. A senior programmer may head a team of programmers whose assignments differ in complexity.

Coder--Converts programmer's instructions into special machine "language" or code.

Console operator--Operates the central control unit or console of the electronic computer. Uses program instruction sheets to determine setup of equipment and operating procedures. Keeps operating records such as machine performance and production reports.

Peripheral equipment operator--Operates converters, printers, and other machines which are a part of the electronic system. If machines do not operate properly, he reports this to supervisor.

Keypunch operator--Operates machine to punch series of holes on cards. These holes represent data or coded instructions for the electronic equipment.

Data-typist--Operates electric typewriter equipped with special keyboard to transcribe coded program instructions or data on magnetic tape.

Tape librarian--Maintains files of tapes and issues them to electronic machine operators when called for. Classifies, catalogs, and cross-indexes reels of tape according to data content. Prepares record for file reference.

Because this is a new field, job titles and duties do not follow a well-defined pattern. For example, in some companies, one person may perform the duties of both the analyst and programmer and a different job title may be used. In some cases, special workers called "tape handlers" may be assigned to change magnetic tape reels on machines; in other cases, this job may be done by the machine operators. In addition to the workers with special titles, a few clerks, messengers, and other officeworkers perform duties related to the electronic processing of data. As in other office operations, a unit supervisor is usually in charge of each specific section of work and higher grade supervisors are responsible for broader areas of work.

Effect of Automation on Clerical Workers

Occupations Affected by Automation

While new occupations are being created because of the use of electronic data-processing systems, other jobs are being

abolished or the functions of workers are being changed. In general, clerks employed in routine and repetitive office jobs are the workers most likely to be affected by the installation of electronic equipment. The machines displace many clerks who sort and file office records or operate various office machines--addressing, adding, calculating, bookkeeping, and billing machines. This does not mean that all people in routine clerical jobs will be displaced. For example, in an insurance company that uses electronic computers, clerks are still needed to number, type, and file insurance policies; to check this work for accuracy, to make changes in addresses of policyholders; to keep records of medical examinations; and for other similar functions. Furthermore, clerks in some jobs may be easily shifted to work that is related to the use of electronic computing systems. For example, companies that switch from mechanical punchcard equipment usually use their key-punch operators to prepare the punchcards or magnetic tapes that are fed into computers. Moreover, if additional operators are needed, typists can easily be trained to do this work. Tabulating-machine operators may also be upgraded and retrained to work on the new machines.

Clerical workers in jobs requiring the use of considerable judgment or contact with other people--secretaries, receptionists, claim clerks, complaint clerks, and bill collectors, to name a few--are least affected by automation. Moreover, the large occupation of stenographer is not likely to be much affected. For many years, dictating machines and other related equipment have been used but the number of stenographers employed has continued to grow rapidly.

Industries Affected by Automation

The greatest headway in the introduction of electronic data-processing equipment is being made in large organizations, particularly in those which use a high proportion of clerical workers in relation to their total employment. So far, government agencies, insurance companies, and public utilities (gas, electric, and telephone companies) all of which have large concentrations of clerical workers, have been among the leading users of electronic computing systems; banks also are expected to become major users of computers in the future.

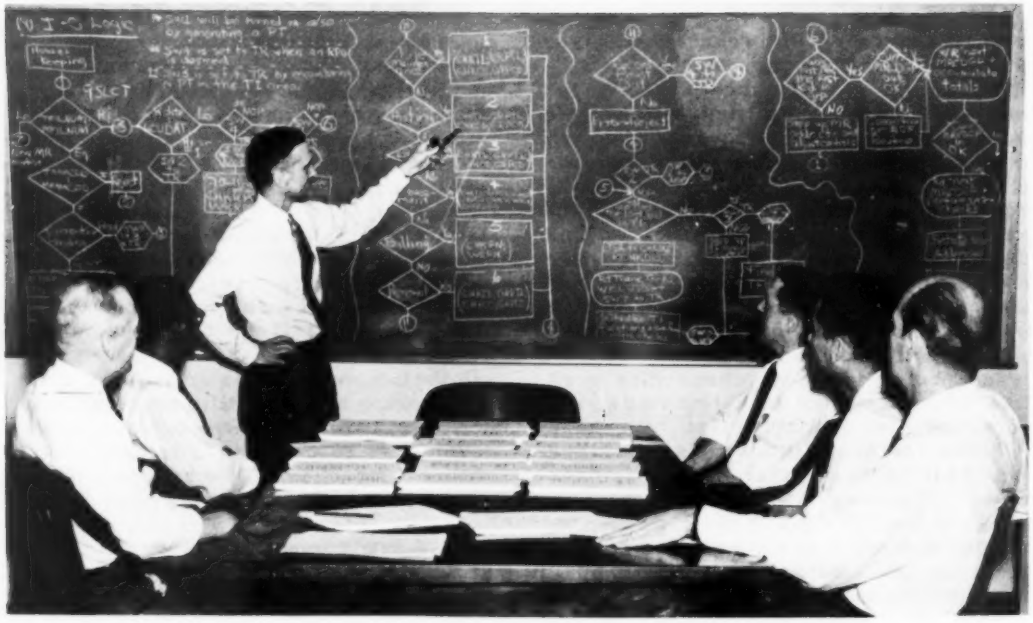
Many big corporations in a wide range of manufacturing industries--electrical equipment, petroleum products, chemicals, aircraft, automobiles, and steel--have also installed electronic computers. These companies not only use their computers as an aid in solving engineering and scientific problems and in the control of machine tools but also use them to perform office functions such as processing payrolls or maintaining inventories.

A few computer centers have also been set up recently to do data-processing work on a fee basis. These centers provide a new source of employment in the occupations related to operating computer systems. Computer centers and most of the central and regional offices of big corporations and government agencies are in large cities. The effects of automation on employment, therefore, will be greatest in these urban areas.

Prospective Effects of Automation on Employment

Because electronic data-processing machines are capable of performing vast amounts of work with relatively few workers, some people have expressed concern that a large part of the clerical work force may be displaced. So far there is little evidence of this. One of the reasons for installing the new equipment is to make possible the handling of greater amounts of increasingly complex data and to provide additional, more timely reports. Thus, the net effect may be greater output per person and a declining rate of growth of clerical employment if the use of electronic equipment becomes widespread.

Although it is still uncertain when office automation will have the greatest



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Senior programmer pointing out steps in a flow diagram to other members of a programming team

impact on clerical employment, the effects are not likely to be extensive for several years. Even in such routine jobs as those of file clerk and adding, billing, or calculating machine operator, many employment opportunities should continue to arise throughout the early 1960's. Since large-scale electronic data-processing equipment is complex and expensive, even big companies take time to weigh carefully the advantages of a computing system. It may take many months to complete the studies needed in arriving at a decision to install a computer. After the equipment is ordered, a great deal of time must be spent in order to plan for, and to train personnel in its use. Furthermore, most companies spend several months--sometimes a year or more--in so-called parallel operations, when the regular clerical staff continues to perform all or part of the work that is being run on the computer. This dual operation gradually tapers off as the details are worked out for a smooth transfer of the functions to the computing system.

In the long run, it is expected that an increasing amount of clerical work in business firms and government agencies will be taken over by electronic computing systems. Employers are faced with the necessity of processing a load of office work that grows heavier as business expands and as functions such as accounting, budgeting, and marketing become more complex. It has been demonstrated that the computers can perform this work with greater speed and accuracy than can a large clerical staff. As companies gain experience in using this equipment, they will be able to shift more and more office functions to computers. Smaller and less expensive computers are expected to be used in a growing number of establishments that cannot afford the more expensive computers. Moreover, other new office machines which will probably become available may be used along with computers to

speed up recording, copying, and other aspects of office work.

These developments will not only increase the output of clerical workers and slow down the growth in clerical employment, but will, at the same time, change the character of many jobs. Just as machine bookkeepers have largely replaced hand bookkeepers in big companies, programmers and computer operators may take over the bookkeeping function. The demand for workers in jobs related to computers will continue to grow. Many of the new jobs--methods analyst, programmer, computer-console operator, and other computing-system machine operators--will generally pay better and require higher levels of skill and training than most other clerical jobs. Moreover, a continued increase is expected in the number of officeworkers in jobs not greatly affected by office automation--for example, secretary, stenographer, messenger, receptionist, and others involving contacts with customers and the public in general.

In the future, as in the past, the greatest number of employment opportunities in clerical work will come from employee turnover. Turnover is exceptionally high in the clerical field, because so many of the workers in these jobs are young women who, after a few years, stop working to marry or to care for children. Employers have cited the high rate of turnover among officeworkers as one of the factors influencing their decision to install electronic computing machines.

The fact that these machines are likely to be used to a growing extent on a shift basis--sometimes around the clock--points to increasing employment of men. Moreover, the extensive use of computing equipment may reduce the number of part-time clerical jobs--most of which are now filled by women. The widespread use of electronic data-processing equipment may reduce the proportion of women employed in clerical occupations. Nevertheless, women will continue to predominate in the clerical field and turnover will provide thousands of job openings each year.

YOUNG WORKERS UNDER 18--TODAY AND TOMORROW

The rapid rise in the number of youth reaching high school and working age expected in the next decade will have far-reaching implications for educators and for those concerned with the work activity of youth. The population 14-17 years of age will reach 14.3 million by 1965, a 40-percent increase over 1957. This increase is bound to have a severe impact, not only upon our already bulging schools, but upon the demand for entry jobs--especially from student and vacation workers.

These are some of the conclusions to be drawn from the U. S. Department of Labor's Bureau of Labor Standards' chartbook, Young Workers Under 18--Today and Tomorrow. This bulletin, consisting of 11 charts with brief accompanying text, describes the major trends in population, school enrollment, and employment age group during the decade 1947-57, and suggests the direction of future trends.

Copies are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 20 cents.

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THE VALUE OF MILITARY TRAINING IN CIVILIAN JOBS

by Charles G. Park

"Learn your trade with the Army Engineers." "Service training provides you with a solid foundation for a brighter, more promising future." "Your Air Force training will be one of your most important assets today--or tomorrow." Young persons, reading such statements on recruiting posters in every post office, have a vital interest in finding out how military service and service training will affect their career plans.

How valuable is military training as preparation for a civilian career? This is one of the more important questions a young person faced with the prospect of military service must have answered. And every young man planning his future today must consider the possibility of spending some time in the Armed Forces.

It is important to remember that under present regulations, a young man's military obligation can be fulfilled in several ways. If he completes college ROTC, he can serve as an officer for either 2 years or for 6 months on active duty, followed by several years in the ready reserve. A young man can also enlist in the service for 3, 4, or more years of active duty. Or, by enlisting directly in a reserve or national guard unit, he can limit his active military service to 6 months followed by $3\frac{1}{2}$ years during which he must attend weekly meetings in the ready reserve. On the other hand, if he chooses to wait to be drafted, he will spend 2 years on active duty with an additional 2 years of weekly reserve meetings. Currently, only the Army is taking draftees.

Another possibility is that, as the number of draft age men increases, a young man who decides to wait for the draft may not be required to serve at all.

The individual who waits to be drafted or enlists in a reserve or national guard unit for 6 months' active duty may gain from 1 to 3 years of civilian work or education over those who choose a regular enlistment. This in effect means choosing between time and military training, since the draftee or reservist is usually not accepted for the longer technical training courses and has no choice of the training he will take. With few exceptions, an enlistment of 3 or more years is the price of Armed Forces technical training, and a young person should consider these alternatives carefully before making a choice.

Opportunities for Training in the Armed Forces

Over the past decade, the military services have made impressive contributions to the sum total of technical skills and "know-how" of the Nation's civilian work force. Many people have received training in the Armed Forces which later proved helpful in qualifying them for civilian occupations. However, the young person who is thinking of enlisting in the services for technical training should first try to find the answers to the following questions: What are my chances of getting the training I want if I enlist? What type of service training will help me most when I am ready for a civilian job? To what extent will my military training qualify me for skilled work in civilian life?

Changes in military technology since World War II have caused a steady increase in the relative importance of "technical" and "mechanical" skills in the Armed Forces. At the end of World War II, enlisted technicians and mechanics made up about 34 percent of the total enlisted strength of the Armed Forces; this proportion had increased to 41 percent at the time of the Korean conflict, and to 45 percent in 1956. All indications point to a

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Soldier and civilian student trainee repair telemetering equipment in an Army laboratory

continuation of this trend in the future.

As the needs of the services for skilled personnel increase, individuals entering the service will have increasingly good chances to receive technical training. The services depend heavily on in-service training for developing their skilled personnel and all branches have training programs to teach a variety of technical skills. The enlistee's education and ability are the most important factors in determining the type and amount of training for which he can qualify. Each branch of service has its own recruiting policy, which may change from time to time, but in all of them a high school education is valuable if the young person wants to qualify for technical training. In the Army, for example, a boy who has completed high school can choose the specific training he wants and be certain of getting that training if he passes the necessary tests and is accepted for enlistment. In the Navy and Air Force, however, the high school graduate cannot choose a specific type of training before enlistment, but he can choose a general area such as electronics, health service, or aviation, with a guarantee of training in some part of his chosen field if accepted. To qualify for training in some military jobs, he must have completed certain courses in high school, such as physics or advanced algebra.

Before acceptance, each high school graduate seeking to enlist must take a battery of intelligence and aptitude tests and must obtain certain scores in specified parts of this test to qualify for various types of training. For example, training in radio repair may require scores above 90 in the mathematical and electrical ability tests. This limits the high school graduate's choice of training to those occupations for which his test scores qualify him. The nongraduate who enlists, like the draftee, has no choice of training and will be assigned on the basis of his test scores according to the needs of the service at that particular time. For this reason, any young person who seriously plans on training for a civilian occupation in the Armed Forces should make every effort to complete high school before he enlists.

Jobs in Which Service Training Is Most Valuable

Military training is, of course, more useful in some civilian occupations than in others. In the course of the research carried on by the U. S. Department of Labor's Bureau of Labor Statistics in preparing the Occupational Outlook Handbook, the following occupations were noted in which large numbers of workers had received all or part of their qualifying training in the Armed Forces:

Aircraft electricians
Aircraft instrument repairmen
Airline pilots
Flight engineers
Airplane mechanics
Radar technicians
Electronic technicians
(includes radio and TV repair)
Business machine repairmen
(electronic data processing)
Meteorologists

This indicates that military training can be directly utilized in civilian jobs in

a few industries such as electronics, aircraft manufacturing, and air transportation, where much of the equipment used is similar or identical to military equipment.

The results obtained in a recent study of the jobs held 2 years after separation by 3,000 airmen released from the Air Force in 1954 also indicate that the most useful contributions of military training have been in those civilian technical skills which are closely related to the new military technology.[1] Of those who held full-time jobs at the time of the study, the proportion using their military training in related civilian jobs was highest (36 percent) in the group with service training in radio and radar maintenance and next highest (23 percent) in the group trained in aircraft and engine maintenance. In less technical occupations, however, the comparable percentages were much smaller, with only 14 percent in supply, 12 percent in food services, and only 4 percent of those with training in communications working in related civilian jobs.

There are many additional jobs in which military training can prove useful. In the building trades, for example, credit toward completing an apprenticeship is often given for related military experience. Many young men, as well as a considerable number of young women, have learned typing, machine accounting operations, stenography, and other clerical skills through in-service training. Occupations such as auto mechanic, draftsmen, and certain technicians jobs in health services are examples of other fields in which many have transferred skills from military to civilian use.

Amount of Training Provided

How much of the skill necessary in a civilian occupation can be learned through service training? First, it should be remembered that the value of military training for a civilian occupation is only a byproduct of that training from the standpoint of the Armed Forces. The services naturally do not regard the development of skills needed by the civilian economy as one of their primary missions, and their training is designed to fill purely military requirements. Second, only higher ranking personnel on a second or subsequent enlistment are eligible for many of the advanced training courses the services offer. A young person entering the service for a single enlistment is seldom given any formal training beyond the initial or "entry-level" training. He gains any further training or experience by actually working at the job.

The value of on-the-job experience gained in the Armed Forces may range from very useful to almost worthless. A great deal of purely manual labor and unskilled work must be performed in the Armed Forces. Since the military occupational structure does not provide for unskilled laborers, low ranking personnel on first enlistments must do this work, which includes "fatigue" details of all types. This work has little value as experience in a skilled occupation. A low ranking enlisted man, classified, for example, as a radio repairman may spend much of his time painting, maintaining grounds, cleaning buildings, and performing kitchen police and guard duty in addition to radio repair work. He may spend as much time at such details as at his assigned work.

The services are also faced with the problem of frequent turnover. This has led military training authorities to simplify the jobs performed and shorten the training time requirements as much as possible. Thus, there may be little relation between military and civilian occupations, even though the job titles are similar. For example, an electronics technician in the service is generally not a qualified electronics technician in the civilian sense. As of June 30, 1956, 13 percent of the total enlisted strength in the armed services had jobs in the general area of "electronics." These included jobs in electronic maintenance, radio operation, aircraft control, and so forth. Even

[1] Sample Survey of 3,000 First-Term Airmen Separated in 1954; Manpower Utilization Division OASD (MP & R), U. S. Department of Defense, 23 January 1957.

though 86 percent of the personnel in the electronics area initially attend formal technical schools before assignment to units, the average training period for these jobs is about 5 months. However, industry and the Armed Forces, meeting in the Electronics Production Board, have agreed that it takes no less than 5 years of intensive training for a high school graduate with a good I. Q. to qualify as an across-the-board electronics technician, while a 1952 Bureau of Labor Statistics survey of 2,000 civilian electronics technicians indicated that at least 2 years of training is necessary to qualify for work in this field.[2]

These differences in training requirements for military and civilian jobs are due largely to the division of maintenance work in the services. The Armed Forces break down such jobs into simple components, and give the service technician only enough training to do the specific job he is required to perform. Frequently, training in the theory, fundamentals, and mathematics that is required to attain full proficiency in such work is not given in the service training program. A service maintenance man is often trained to repair a single system, and to do this on a "go--no go" basis. He substitutes parts or sets of parts in key positions until the defective part is found and the system operates correctly. The defective part or set of parts is then returned to the factory or sent to a civilian contractor where the actual repair work is done.

This does not mean that training of this type is of no value in some related civilian occupations. It does, however, point up the fact that the great bulk of training given by the services will fall somewhere between the extremes of having little civilian value and of completely qualifying a young man for a civilian occupation. A young man trained as a machinist or electrician in the Armed Forces, for example, will gain useful work experience and get credit toward apprenticeship, but will probably still have to get further training to qualify for these occupations in civilian life.

[2]The Mobility of Electronic Technicians, Bulletin No. 1150, Bureau of Labor Statistics, U. S, Department of Labor, U. S. Government Printing Office, 1954.

Implications

The high school student who plans to enlist in the service for vocational training can do much to increase his chances of benefiting from his service experience. Finishing high school is extremely important, since an individual without a high school education who enlists in the Armed Forces is offered no choice of the training he will receive. While still in school, the student should take as many courses as possible which are related to his long-run career plans since this may enable him to qualify for the training he wants when he takes the service classification tests.

To the extent that he is offered a choice of training at enlistment, the young person may want to consider some of these questions before choosing. Which courses are most directly related to the occupation for which I eventually want to qualify? Which provide the longest period of formal training? Which offer the most instruction in tools, fundamentals, and general theory that can be applied to civilian work as well as the specific military job?

The difference between the time spent on active duty by a young person who enlists and one who is drafted or enters the reserves is considerable. A young person who ultimately plans to enter a civilian job should carefully weigh the value of the training he can get by enlisting against the time spent in the service. On the other hand, a career in the Armed Forces themselves can offer attractive possibilities for young people and many may want to investigate the possibility of a military career before making a choice.

EMPLOYMENT OUTLOOK FOR BIOLOGICAL SCIENTISTS*

by Rose K. Wiener

Biological scientists study the world of living things--men and microbes, wild and domestic animals, plants and insects, birds and fish. The number and variety of plants and animals are so immense and the life processes so varied and complex that biologists must, of necessity, become specialists. Some spend a lifetime trying to learn as much as possible about a particular kind of animal or plant. Others are interested in how the body functions and study such things as the circulatory system or the nervous system, how food is digested, or the ways in which organisms are affected by disease. Some are interested in the evolution of living organisms, in the mechanism of heredity, and in the ways in which environmental factors, such as major changes in climate or radiation, have affected the development of different species or might do so in the future.

All biologists can be grouped into three broad and general subdivisions on the basis of the variety of organism with which they work: botanists (plants), zoologists (animals), and microbiologists (microorganisms). Those whose work cuts across several of these subdivisions, as is frequently the case with college teachers, may simply call themselves biologists. Within each major subdivision are many subspecialties, which may relate to the specific type of organism studied, as in the case of mycologists, who are botanists studying fungi; or may indicate the sort of approach used in studying organisms, as is the case of geneticists, who may be botanists, zoologists or microbiologists studying the mechanisms of heredity of sweet peas, fruit flies, or viruses.

*This article is the first of a series presenting new and revised information on fields of work covered in the 1957 edition of the Occupational Outlook Handbook. It is based on the Bureau's continuing program of occupational outlook research.

Nature of Work

The majority of biological scientists are engaged chiefly in research. This research is of many kinds. It may be conducted inside a laboratory or outdoors, at the far corners of the world or near a quiet university town. A botanist exploring the volcanic Alaskan valleys to see what plants live in this strange environment and a zoologist searching the jungles of the Amazon valley for unknown specimens of animals and fish are both doing field research. The agronomist does experimental research with crop plants, growing seeds under controlled conditions to see how various strains compare in their resistance to pests, changes in climate or soil, or other factors. Some of them work at State agricultural experiment stations. Many entomologists do field research at one of the many field stations maintained by the U. S. Department of Agriculture in this country and abroad. They investigate the quantity and distribution of insects, the causes which promote their growth, and the methods of controlling them. Others work in laboratories, sometimes as part of a team of specialists in several biological sciences, testing the effectiveness of various chemical insecticides and their possible hazards to human and animal life.

Some of the most exciting research in the field of biology is being done in microbiology, including bacteriology, physiology, biophysics, genetics, and pharmacology, which are often grouped together with biochemistry as the field of experimental biology. The microbiologist works in a laboratory where light, temperature, humidity, and other environmental factors can be controlled in conducting experiments. He works largely with test tubes, cultures, microscopes, and a variety of specialized laboratory equipment. The microbiologist who cultures viruses within tissues living in test tubes, so that

he can observe virus action more closely and discover how they multiply, is doing work which will give us a better understanding of the borderline between life and nonlife. This work may eventually lead to the discovery of new vaccines to control some of our most stubborn infectious diseases, such as tuberculosis, rheumatic fever, and influenza. The soil bacteriologist analyzes samples of soil to find the bacteria, molds, algae, protozoa, and other microorganisms in the different soils so he can search for the relationship between such organisms and soil fertility; plant diseases, and the growth, processing, and storage of crops. The physiologist may use the methods of chemistry and biophysics to find out how cells utilize the energy of food for such processes as muscular coordination, how hardening of the arteries develops, or how muscles respond to impulses of the nervous system. The biophysicist uses the electron microscope to visualize tissues down to their smallest units, the molecules; he may use nuclear reactors, X-ray machines, microscopes, and photomicrographic apparatus to study the effect of high energy radiations on cell division in, say, immature insects. The geneticist in his search for more information about the mechanisms of heredity conducts experiments with fruit flies, guinea pigs, or other animals or plants that reproduce rapidly. Pharmacologists conduct experiments with rats, guinea pigs, monkeys, and

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A biologist studying the effect of radioactivity on living tissue

other animals to discover the effects of drugs, gases, dusts, poisons, and chemicals on the tissues of living creatures.

In all of these different types of research, the biologist must have at his command the fundamental techniques of biological and chemical research, such as skill in the use of microscopes and other laboratory equipment, in making and staining sections, and in classifying and identifying specimens. In the experimental field, advanced techniques and tools taken from the field of chemistry or physics are frequently used and, to an increasing degree, a knowledge of mathematical and statistical procedures is needed to organize and analyze the data gathered, owing to the enormous number of variable factors involved.

Teaching in colleges and universities is the major function of about one-third of the biological scientists. However, most college teachers of biological sciences combine independent research with their regular teaching duties and in some large institutions spend the major portion of their time on research. The college teacher is likely to have some classes to which he lectures several times a week, and possibly a group of graduate students who may attend seminars and conduct research projects under his guidance as part of their training to become professional biologists. College professors frequently help their graduate students find jobs, counsel incoming students, attend university committee meetings, and handle a variety of other administrative duties in connection with their teaching work.

More than 1 in 10 biological scientists do management and administrative work. This may involve supervising and administering industrial, nonprofit, or governmental laboratories engaged in research or in testing foods, drugs, insecticides, and other products. High-level specialists in biology are used to act as liaison between the Federal Government and the experiment stations at the State universities, and to aid in the planning, development, and evaluation of research programs at these stations.

Relatively small numbers of biologists are engaged in a variety of other types of work, such as consulting, writing, routine testing and technical sales or field service work for industrial firms. This involves teaching company salesmen and prospective purchasers the value and proper use of new chemicals when used as food preservatives or insecticides or for other purposes. Biologists in this group, other then consultants and writers, are sometimes described as "biological technicians."

Where Employed

Roughly 40,000 scientists were employed in the basic biological sciences in early 1958. This estimate includes zoologists, botanists, microbiologists, and the many subspecialists in these broad groups. It excludes physicians, foresters, and many others in health service and agricultural occupations who use biological knowledge to solve problems peculiar to their work but are not usually considered biological scientists.

More than half the biological scientists were employed in colleges and universities, according to a 1954-55 survey of biological scientists with a graduate degree or a minimum of 4 years of experience in addition to a bachelor's degree. Government organizations--Federal, State, local, and international--employed approximately one-fourth of the biological scientists. About 10 percent worked for private industry and a small number, perhaps 2 percent, were self-employed. About 5 percent were in nonprofit organizations, mainly hospitals, clinics, and privately financed research organizations or foundations. The remainder were employed in educational institutions other than colleges and universities.

The type of organization in which the biologist is most likely to be employed depends on his specialty. More than two-thirds of those specializing in anatomy, physiology, zoology, botany, and genetics and a majority of biologists in most other specialties are employed in colleges and universities.

Government agencies--Federal, State, and local--are the principal field of employment for agronomists, entomologists, and fish and wildlife biologists. Biological scientists specializing in agronomy, horticulture, animal husbandry, entomology, or other subjects related to agriculture are employed chiefly in State agricultural colleges and universities and in agricultural experiment stations operated by these universities in cooperation with the Federal and State Governments. The experiment stations provide teachers and students with many opportunities for research. In addition, they offer full-time positions which provide valuable training in research. Teachers specializing in other biological sciences, particularly those important to medicine, are most often employed in liberal arts institutions, including those in State universities and in medical schools.

A large majority of the biologists in government agencies are employed in the Federal Government--principally in the Department of Agriculture, the Federal agency employing most entomologists, botanists, plant physiologists, plant pathologists, horticulturists, geneticists, husbandry specialists, and parasitologists. The Interior Department employs nearly all the fish and wildlife biologists in the Federal Government. The Defense Department--mostly the Army--and the United States Public Health Service employ a good many pharmacologists, parasitologists, physiologists, entomologists, and specialists in other branches of biology; these two agencies, together with the Veterans Administration, also account for 85 percent of the microbiologists in the Federal service.

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Biologists dissecting a plant within a sealed chamber designed to keep moisture at a desired level

State Governments employ about half of all fish and wildlife specialists, and rather small numbers of horticulturists, agronomists, entomologists, husbandry specialists, and phytopathologists (plant pathologists). City and county health departments employ a good many microbiologists in the detection, control, and prevention of disease.

Private industry is the second largest employer of pharmacologists and microbiologists and is a growing source of employment for agronomists, entomologists, and phytopathologists as well as other biological scientists. Most of the microbiologists and nearly all the pharmacologists in this field of employment work for pharmaceutical firms which manufacture biological products--toxins, toxoids, antiserums, antibiotics, and similar products. Microbiologists, including bacteriologists, are also employed in the food industry and in firms manufacturing tobacco, leather, organic acids, and other industrial products. Entomologists are employed mainly in the food industry to develop methods of protecting stored foods from insect pests, and in the chemical industry to do research in developing and testing insecticides. Phytopathologists are most often employed by firms manufacturing agricultural chemicals to combat plant diseases.

Although the number of biological scientists employed in nonprofit organizations is small, these agencies account for roughly 30 percent of the specialists

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in animal pathology and biophysics and 20 percent of the microbiologists. They also provide some employment opportunities for specialists in other branches of biology.

Training and Other Qualifications

Graduate training is necessary for employment in most professional positions in the biological sciences. The doctorate is generally required to achieve full professional recognition in the biological sciences and is practically a prerequisite for higher level administrative and college teaching positions and for advanced research in the field of experimental biology. The Ph.D. or its equivalent is, to an increasing degree, a requirement for positions involving independent research.

Biologists holding the master's degree are qualified for most entry positions in their specialty, including college teaching and research. Most biologists with this level of education work in colleges and universities or in government agencies. They are also frequently employed in related fields such as agricultural extension work and high school teaching.

Many of the biological sciences, particularly those in the area of medical biology, offer opportunities for persons with bachelor's degrees to work as high-level technicians. In some specialties, persons holding the bachelor's degree can become junior research workers or obtain other professional entry positions. However, promotional opportunities for those without graduate training are, except in unusual cases, restricted to intermediate-level positions. In general, persons holding the bachelor's degree with a major in an appropriate specialty are qualified for positions involving inspection and testing, production and operations work, technical sales and service, routine research, and administrative duties.

Students planning a professional career in the biological sciences are advised to obtain, during the first 4 years of college, the broadest possible training in all branches of biology and in related sciences. The competent biologist needs to have not only an intensive knowledge of his own specialty but also a broad background in the fundamentals of biology and related sciences in order to do research and interpret correctly the results of his studies and experiments. All students in the biological sciences need training in organic and inorganic chemistry, physics, and mathematics. Students interested in experimental biology research need advanced training in chemistry, mathematics, statistics, and, in some cases, physics. Students specializing in agricultural and soil bacteriology need courses in botany and plant pathology as well. Students should also take courses which provide laboratory experience and at least one field course, in order to relate their observations in the classroom and laboratory to the functioning of living plants and animals in their natural habitat. Intensive training and practice in laboratory techniques and the use of laboratory equipment is especially important. Most research and teaching in the biological sciences require skill in laboratory work which can be developed only through practice. Such training is likely to be a prerequisite for employment in many entry positions in the field of medical biology research.

Most colleges and universities offer an undergraduate major in biology or in one of the other biological or agricultural sciences. However, course offerings vary widely and students are urged to examine courses listed in college announcements very carefully in order to choose the college best suited to their needs. In general, the liberal arts colleges emphasize training in the basic biological sciences and in the medical aspects of biological science. The agricultural colleges, mostly State universities and land-grant colleges, emphasize training in agriculture and the agricultural sciences. The State universities and land-grant colleges offer special advantages to those interested in agricultural sciences and in entomology since their agricultural experiment stations provide many opportunities for practical training and research work.

Employment Outlook

Employment opportunities for biological scientists with graduate degrees are expected to be very good through the early 1960's. Persons with a bachelor's degree in some areas of biology are also likely to find very good employment opportunities.

Although the increased demand for biologists in the 1960's is expected to apply to most specialties, the greatest rise in demand will be in the field of experimental biology. Research into problems important to medicine is expected to increase very substantially and existing shortages of scientists with a Ph.D. degree in microbiology, physiology, and pharmacology will probably be greatly accentuated. This research will also require many more biologists with lesser degrees qualified to act as junior professional assistants and as technicians. Bacteriologists and physiologists, already in short supply in 1958, are likely to find employment opportunities exceptionally good.

The demand for biologists in other specialties will rise more moderately. Shortages of personnel with a bachelor's degree in entomology or in plant sciences, qualified to aid in regulatory and control programs, were reported in early 1958. These shortages may continue unless there is an increase in the number of students who specialize in these subjects and who are willing to do the necessary traveling or moving.

Over the long run, the outlook for biological sciences is one of substantial continued growth, although the rate of growth in various specialties will differ and specialties which will be most affected can be described in only the most general terms. The potentialities for research in the biological sciences are many. In the complex problems of human health and disease, in applications of biology to agricultural and industrial problems, and in other areas, completion of research projects serves only to highlight the need for new research and for specialists well qualified to conduct it.

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A biologist checking a tank of snails being propagated under carefully controlled conditions

Earnings and Working Conditions

College graduates with bachelor's degrees majoring in different fields in biology had average starting salaries ranging from approximately $350 to $390 a month in 1957. The groups with the lowest average starting salaries were those with degrees in microbiology or parasitology; the groups with the highest average starting salaries were those with degrees in entomology, wildlife biology or wildlife management, ecology, genetics, zoology, and general biology. Graduates with master's degrees had average starting salaries ranging from about $370 to $440 a month, depending on their specialty. The lowest of these were in fishery biology and related subjects, and the highest were in plant science. These data include earnings of many graduates who took business administration or selling or other types of jobs which could not be considered as in the field of professional biology but exclude the earnings of those who entered the Federal Government. De-

spite these limitations, the data provide a good indication of the salary levels prevailing for biologists entering the employment field in 1957.

Salaries of biological scientists as well as all other white-collar workers in the Federal Government were raised in mid-1958. Under the revised Federal salary scale, biological scientists with the Ph. D. degree but no experience start at $5,985; inexperienced scientists with the bachelor's degree usually start at $4,040. Within the discretion of the Civil Service Commission, higher starting salaries may be paid to scientists with exceptional qualifications or in shortage categories. As of mid-1958, pharmacologists were in this group; those with the master's degree started at $5,430, and those with the Ph. D. but without experience at $6,285.

Experienced biologists with a doctoral degree or a medical degree who were working in the field of experimental biology in 1957 had median earnings of $8,400, according to a survey by the Federation of American Societies for Experimental Biology. The survey covered more than 9,200 biologists with advanced degrees who specialized in physiology, biochemistry, pharmacology, pathology, nutrition, and microbiology. It indicated further that biologists in universities had the lowest median salary, about $7,700, and those in private industry the highest, about $10,500. Substantially higher salaries were paid for administrative than for research work.

TEACHER-EXCHANGE PROGRAM

More than 600 teachers from the United States and 42 other countries will take part in the 1958-59 teacher-exchange program. Arranged by the Office of Education, U. S. Department of Health, Education, and Welfare, the program is part of the United States International Educational Exchange program of the Department of State. With this year's two-way exchange, nearly 5,000 teachers from the United States and 64 other countries will have participated in the plan, which is now in its 13th year.

Another 121 teachers from the United States will teach in foreign countries and 20 teachers from other countries will teach in United States schools on one-way assignments during 1958-59. Summer seminars in Columbia, France, Germany, and Italy are now being attended by 129 American teachers.

Information on the teacher-exchange program may be obtained from U. S. Department of Health, Education, and Welfare, Office of Education, Washington 25, D. C.

HIGH SCHOOL LEAVERS IN VANDERBURGH COUNTY, IND., 1953-56

How High School Graduates and Dropouts Fared in an Industrial Area

by Dean Long and James E. Morlock*

Despite a steady increase in the proportion of high school graduates who go on to college, the great majority of the young people leaving high school still go directly into the labor force to begin their careers. How do these young men and women adjust to the world of work? Do those who leave high school before graduation have more difficulty in obtaining satisfactory jobs than those who graduate? How do personal circumstances such as family background and plans to marry influence decisions to leave school?

These are some of the questions which a recent study carried out by staff members of Evansville College was designed to answer. The survey, made in Vanderburgh County, Ind., in the summer of 1957, covered all the young people who graduated from high school but did not go on to college or who dropped out of high school before graduating, from September 1953 to June 1956.[1] Vanderburgh County is 1 of 6 areas[2] selected by the U. S. Department of Labor for special studies of school leavers, who are of concern because they are in the age group that consistently has a higher unemployment rate than most age groups.

Characteristics of the Area

Evansville, with about 137,000 population, is the chief city in Vanderburgh County, located in the southwestern part of Indiana on the Ohio River. Its labor market includes all of the county as well as Henderson County, Ky., just across the river. The total population is about 214,000. Since 1953, this area has been one of labor surplus. It is an industrialized area developed around the manufacture of nonelectrical machinery. Large plants are characteristic, but many of them are operating at less than capacity.

The method employed in the study consisted of (1) a study of the school records of every school leaver, which gave such basic information as sex, I. Q., highest grade completed, number of vocational courses completed, official reason for leaving school, and age at leaving; (2) interviews with a random sample of 28 percent of these people tracing their employment history from the time of leaving school to the summer of 1957, and adding personal data, such as student's own reason for leaving school and marital status; and finally, (3) comparisons of school records with the employment histories to find out whether success in school resulted in a successful adjustment to the world of work.

The 1953-56 records of the public high schools and the two Catholic high schools which serve Vanderburgh County showed a total of 4,227 students who did not continue their formal education beyond high school or who dropped out

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[1]The study was made under a contract arrangement with the U. S. Department of Labor's Bureau of Labor Statistics.

[2]See reports on school leavers in Harrison County, W. Va. (in The Occupational Outlook, May and October 1957, pp. 6-10 and 23-28, respectively).

before graduating. A sample of 1,183 of these young people was chosen for personal interview, but by the summer of 1957, when the interviewing was done, information on the details of their work experience could be obtained only from 698 who were still living in the county. This group divided into 426 graduates and 272 dropouts. Another thirteen could not be traced at all. The remaining 472 were living outside of Vanderburgh County. For these, information was obtained from family members or neighbors, mainly about why they had left the county and their present employment status.

Why Students Dropped Out of High School

When they were interviewed in 1957, the dropouts who were still living in the county gave reasons for leaving school that were different in many instances from the reasons shown on their school records. (See table 1.) When school officials were unable to get the reason directly from the student upon withdrawal, they had to depend upon indirect information. Some students, understandably, sought to give "acceptable" reasons and may have suppressed the real reason. For example, according to the school records, only 18 percent of the dropouts (29 boys and 19 girls) gave "going to work" as a reason for leaving, but when interviewed, 25 percent gave this as the reason. Of the girl students, 46 percent gave "marriage" as a reason for dropping out when interviewed, but the school records show that only 38 percent gave "marriage" as a reason at the time of leaving school. Perhaps the fact that these girls were married by the date of the interview made this seem, in retrospect, a good objective reason. When interviewed, only 28 percent of the dropouts gave "adverse school experience" as their reason for leaving school, but the school records showed this reason for 41 percent of all these dropouts.

Characteristics of the Dropouts

A substantial proportion of all dropouts studied came from large families. About 45 percent of them had 4 or more brothers and sisters as compared with 28 percent of the graduates with this number of brothers and sisters; and only 6 percent of the dropouts, compared with 14 percent of the graduates, had no brothers or sisters.

Only 2 out of 5 graduates had parents who desired more education for them and, where encouragement existed, it was in favor of the sons--53 percent of the boy graduates, compared with only 30 percent of the girl graduates, had parents favoring their further schooling.

About 30 percent of the dropouts had I. Q.'s of less than 85, while less than 10 percent of the graduates had these

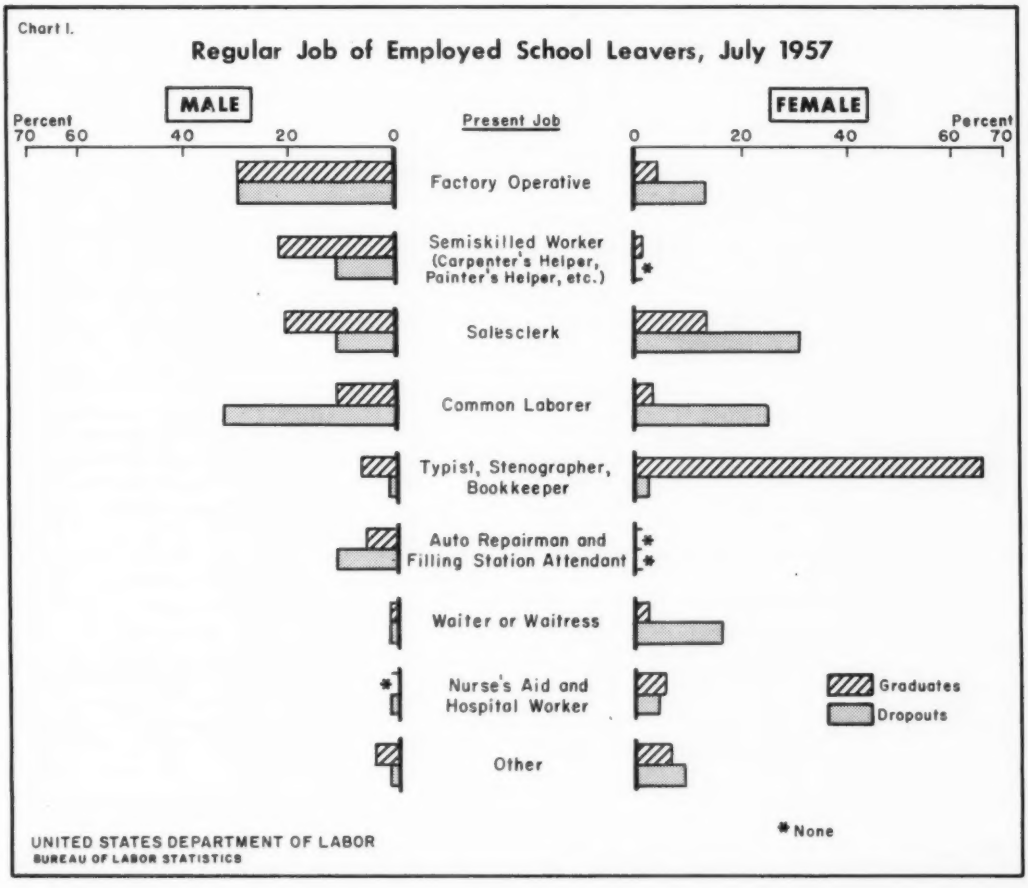
TABLE 1. Reasons for leaving school, according to school records, and as given by dropouts in interviews

Reasons for leaving	School records						Interviews					
	Both sexes		Male		Female		Both sexes		Male		Female	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	264	100	109	100	155	100	264	100	109	100	155	100
To go to work	48	18	29	27	19	12	67	25	47	43	20	13
Marriage	61	23	2	2	59	38	78	30	6	6	72	46
Adverse school experience	107	41	56	51	51	33	74	28	35	32	39	25
Other reasons	48	18	22	20	26	17	45	17	21	19	24	16

low scores. At the other extreme, 23 percent of the graduates had I.Q.'s of 110 and above, which is the level generally considered necessary for success in college work. Only 8 percent of the dropouts had these high scores. This would indicate a rather high potential for college work among the graduates compared with a much smaller potential ability for college among the dropouts.

Employment Experience of All School Leavers Interviewed

The survey shows what happened to all school leavers interviewed in terms of employment by July 1957. Of the boy graduates employed at that time, 30 percent were factory operatives and 22 percent were working in semiskilled jobs (carpenters' helpers, painters' helpers, etc.). (See chart 1.) Of the boy dropouts employed in July 1957, 33 percent were working in common laborer jobs and 30 percent were factory operatives. The type of jobs obtained by the boy graduates and boy dropouts did not differ strikingly. However, among the girls there is a sharp contrast between graduates and dropouts. Sixty-six percent of the girl graduates employed in July 1957 were typists, stenographers, or bookkeepers, and 13 percent were salesclerks. Thirty-one percent of the girl dropouts were employed as salesclerks, and 25 percent were in jobs classed as common labor.



Only one girl dropout employed in July 1957 was in office work.

A comparison of the first regular jobs of the school leavers was made with their regular jobs in July 1957, when they were interviewed. This showed that 58 percent of the boy graduates, 73 percent of the girl graduates, 51 percent of the boy dropouts, and 60 percent of the girl dropouts were still in their first jobs. However, their current occupations proved in many cases to be different from their job aspirations. For example, 41 percent of the boy graduates reported that, while in school, they had hoped to be mechanics or welders, but only 22 percent actually were in such jobs in July 1957. About the same proportion of the boy dropouts --40 percent--reported an ambition for this type of work, but only 11 percent were in such jobs. Only 58 percent of girl graduates wanted to do secretarial work, but 66 percent employed in July 1957 were doing this work. Fifty percent of the 135 girl dropouts reported that, while in school, they wanted to do secretarial work, but as has been noted only one of them had this type of job in July 1957. Thus, the girl dropouts seemed to be the most unrealistic in their plans while in school, since they did not remain in school long enough to meet the requirements for such jobs.

The employment experience of school leavers between leaving school and the July 1957 interview, irrespective of employment status at that date, is shown in table 2. Of the school leavers in the labor force (at work or seeking work) during the survey, only 1 boy graduate, 3 boy dropouts, and 3 girl dropouts looked for jobs but never found employment. Thirty-one percent of the girl dropouts had never worked or looked for work. As of July 1957, 8 percent of the school leavers who were then in the labor force were unemployed--4 percent of the graduates and 23 percent of the dropouts. The nationwide unemployment rate for July 1957 for ages 18-24 was 7.7 percent. Thus, the dropouts were much more affected by unemployment than the graduates, who fared somewhat better than the average American in this age group.

TABLE 2. Employment experience of school leavers as of July 1957

Work experience	Graduates		Dropouts	
	Boys	Girls	Boys	Girls
Total school leavers	174	252	113	159
Total ever in the labor force	168	232	106	110
Percent ever in the labor force	97	92	94	69

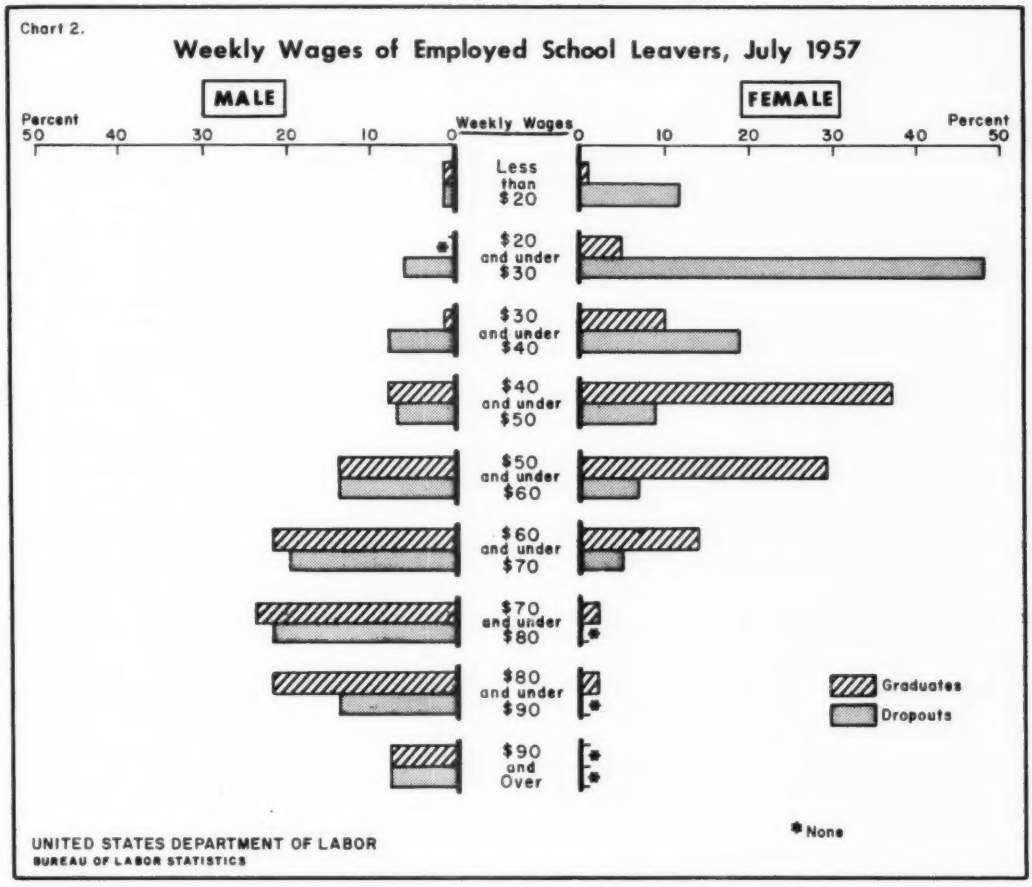
Earnings

For the girls, there was an unquestionable financial advantage in graduating from high school, as chart 2 illustrates. Sixty percent of the girl dropouts received wages of less than $30 a week in July 1957, while only 6 percent of the girl graduates received these wages. Sixty-six percent of the girl graduates received at least $40 but less than $60 a week, whereas only 16 percent of the girl dropouts received wages of this amount. None of the girl dropouts received as much as $70 a week, while about 4 percent of the girl graduates received $70 or more a week.

The earnings differential between boy graduates and dropouts was not so great. The median wage received by the boy graduates was $72, whereas the boy dropouts had a median wage of $67 a week. More than a third (36 percent) of the boy graduates earned from $50 but less than $70 per week, but nearly another third (30 percent) received wages of $80 and above. However, although about the same proportion of boy dropouts (34 percent) as boy graduates were in the wage bracket $50 but under $70 per week, only about one-fifth (22 percent) received wages of $80 or more.

Incidence of Unemployment

Although the wages of boy graduates and dropouts are not markedly different,



there appear to be some other advantages for graduates. Of the school leavers in the labor force in July 1957, irrespective of their employment status at that date, 45 percent of the graduates (both sexes) had experienced no unemployment, but only 14 percent of the dropouts were as fortunate.

Other Findings

For young jobseekers, applying in person was the most common method of getting a job, followed by aid of relatives or friends. Of all those employed in July 1957, 39 percent had obtained their jobs by applying in person and 31 percent had obtained them through relatives and friends.

Upon leaving school, slightly more than one-fourth of the boys ever in the labor force and one-third of the girls ever in the labor force registered with the State Employment Service. Of those registered, 13 percent of the boys and 24 percent of the girls received their first jobs through this service.

Three-fifths of all the school leavers studied were still in Vanderburgh County in the summer of 1957, and of these, three-fifths were girls and two-fifths were boys. Nearly three-fourths of all those remaining were graduates, who showed much less mobility than the

dropouts. The greater difficulty that dropouts had in finding employment may have prompted them to seek work elsewhere.

A count of school leavers who remained and those who left the county by year of leaving school shows that the outmigration was somewhat less in the middle year of the survey, when general business conditions were better in Evansville.

Four hundred and seventy-two (of the 1,053 school leavers both in and out of the county whose marital status was indicated) were married, and eleven were widowed, divorced, or separated, leaving only little more than half still single by the summer of 1957. Almost half of the married school leavers already had children to care for. Thirty-five percent had 1 child in the family and 12 percent had 2 or more children.

Disability affected a very minor proportion of all school leavers. Among 698 persons directly interviewed, the long-term disabled numbered only 39--30 boys and 9 girls. Half of them were employed, 18 of the employed being boys. Fifteen reported that their disability prevented them from getting jobs, 22 said that this did not prevent them from working, and 2 did not respond to the question. Thirty of the 39 said that their disability limited the kind of jobs they could get. About 3 out of 10 were disabled because of chronic illness, about one-fifth had visual handicaps, and another fifth had hearing and speech defects. The remaining group, about three-tenths, had deformities or were crippled.

Observations

Although most graduates and most dropouts in Evansville who wanted jobs obtained them fairly promptly, the type of job apparently was such that irregular employment and lack of opportunities for advancement are likely to be characteristic of the work histories of most of the school leavers. Positions as salesclerks in small retail stores, waitresses, some factory operatives, and common laborers may offer little chance for advancement.

The period surveyed was brief and most school leavers had not yet reached their stride in the world of work. The amount of education of the dropouts, however, gives little basis for expecting them to progress much further.

Early marriage is an important factor among both sexes in terminating formal schooling with high school graduation or before. Cultural patterns among parents who have had little schooling tend to be transmitted to their children, who may follow in the same path--by dating and marrying at an early age. Such a pattern often leads them away from school as soon as the law permits.

School curriculums are not well adapted to the needs of these young people who, perhaps because of lower capabilities or inadequate cultural background, do not stay in school. The status of these people emphasizes the need for more vocational training, as well as the need for education which is more functional and less traditional, and which will develop skills.

CAREERS FOR WOMEN IN SCIENCE*

by Mildred S. Barber
Women's Bureau

The rapid growth in the demand for scientists has resulted in shortages of these personnel in industry, government, and classrooms. In addition, the long-run outlook for continued expansion of employment makes these fields attractive as lifetime careers. As a result, this is a favorable time for young women with the required capabilities to prepare for work in a scientific field. The exact number of women scientists is not known, but rough estimates indicate that there are more than 12,500 women astronomers, biologists, chemists, geologists, meteorologists, and physicists, representing about 6 percent of all these scientists in the United States.

Degrees in Science for Women

Significant increases in the number of science degrees granted to women have occurred in the last few years.

During the school year ending in June 1956, the number of degrees in the biological sciences granted to women increased by 15 percent over the previous year, whereas all degrees granted to women increased by only 7 percent. In 1956-57, the number of women receiving degrees in biological sciences again increased--by 5 percent--the same gain as in total degrees granted to women.

In the physical sciences, the first significant increase in degrees granted to women occurred in 1954-55, when there was a 9-percent increase in these fields despite a small decrease in the total number of degrees granted to women. The following 2 years also showed greater percentage increases in the numbers of degrees granted to women in the physical sciences than in all degrees granted them.

During the school year ending in June 1957, 5,380 women received degrees in the 6 sciences previously

"...Obviously, steps must be taken to break down employment barriers to women in science, engineering, and the technician fields. Public education programs of many varieties are needed to encourage young women to undertake science and engineering studies and to ensure that they receive satisfactory employment after training. Employment requirements and specifications, job content, employment conditions, and environment need to be reconsidered. Long established prejudices against women in engineering and science need to be broken down not only among employers, supervisors, and co-workers, but among the women themselves.

"In its publications and public statements, the Committee has pointed out the advantage and, indeed, the necessity of developing the full potential of the Nation's womanpower qualified for scientific and technological pursuits."

--President Eisenhower's Committee on Scientists and Engineers

*This article supplements the sections on scientists in the 1957 Occupational Outlook Handbook. For up-to-date information on biological scientists, see article on page 14.

mentioned; 4,654 received bachelor's degrees; 549 received master's degrees; and 177 received doctorates. (See table.) However, less than 5 percent of all women college graduates majored in science, compared with 10 percent of men graduates. Nine out of ten of the women science majors took their degrees in biology or chemistry.

Science degrees granted to women, school year 1956-57

Selected sciences	Total	Bachelor's degree	Master's degree	Doctorate
Total.....	5,380	4,654	549	177
Astronomy...	5	3	2	---
Biology	3,625	3,144	369	112
Chemistry...	1,476	1,294	134	48
Geology.....	107	89	16	2
Meteorology.	3	2	---	1
Physics.....	164	122	28	14

Source: U. S. Department of Health, Education, and Welfare, Office of Education. Higher Education, March 1958.

Preparation for a Career and Qualifications

The bachelor's degree with a major in a particular field of science is considered the minimum requirement for beginning work as a professional scientist. Persons without degrees are almost always limited to jobs as scientific aids or assistants, performing relatively routine assignments. Advancement to professional work requires at least the bachelor's degree. Because a trend toward higher levels of education is rapidly developing in all the sciences, however, even holders of the bachelor's degree may be limited to routine assignments as laboratory assistants, computers, data analysts, assistants to scientists, and other technician positions. As a result, some science graduates who take technicians jobs immediately after obtaining the bachelor's degree continue to study at night in order to qualify for the master's or Ph. D. degree. Other arrangements for advanced study include part-time or full-time jobs that permit the employee to take daytime courses and to make up lost work hours during evenings and weekends.

For many positions, especially those in research and college teaching, advanced degrees are required for entry into a job as well as for advancement. For women, in particular, degrees beyond the bachelor's level are especially important since these higher levels of educational attainment accentuate the individual's capacity for scientific work and provide evidence of successful scholarship. In a sense, women are still pioneering in scientific fields, and high levels of educational attainment, together with research experience at the graduate level, are among the best evidences of scientific competency.

Proportion of Women in the Different Sciences

Of the more than 100,000 chemists currently employed in the country, only 6,000 to 8,000 are women. A large increase in the number of women chemists occurred between 1940 and 1950, according to the Census of Population. Only 1,600 women chemists were reported in the country in 1940; by 1950 the number had increased to 7,400.

Biological scientists (including agricultural scientists) are the second largest group of scientific personnel. It is estimated that there are at least 50,000 persons in this field, of whom 5,000 or more are women. In most branches of biology, women represent a larger proportion of total employment than in other science fields. A 1951 survey by the National Scientific Register, in cooperation with several professional societies, showed that women comprised more than one-fifth of the microbiologists, and almost one-fifth of the total engaged in marine biology, human biology, biometry, and general biology. Women constituted about 12 percent of those in general plant sciences and in genetics; in pharmacology (the study of drugs) and in the animal sciences, women represented more than 8 percent. In contrast, the large field of agricultural sciences had only 1 woman among every 200 of its professional scientists.

COURTESY OF OAK RIDGE NATIONAL LABORATORY

A biologist determines effects of radiation on white corpuscles of a mouse

Relatively few women are employed as geologists--about 5 percent of an estimated 15,000 total employment. Of the more than 20,000 physicists in the United States, it is estimated that at least 600 (some 3 percent) are women. Women meteorologists are not numerous, and are estimated to comprise only 2 percent (140 to 160) of the estimated 7,000 to 8,000 meteorologists in the United States.

The importance of the science of astronomy overshadows the fact that this field engages only 450 to 600 professionals, the smallest group among scientists. Women comprise some 12 percent of all astronomers, but the actual number--about 60 to 65--is, of course, very small.

Entry Jobs of Recent Women Graduates in Science

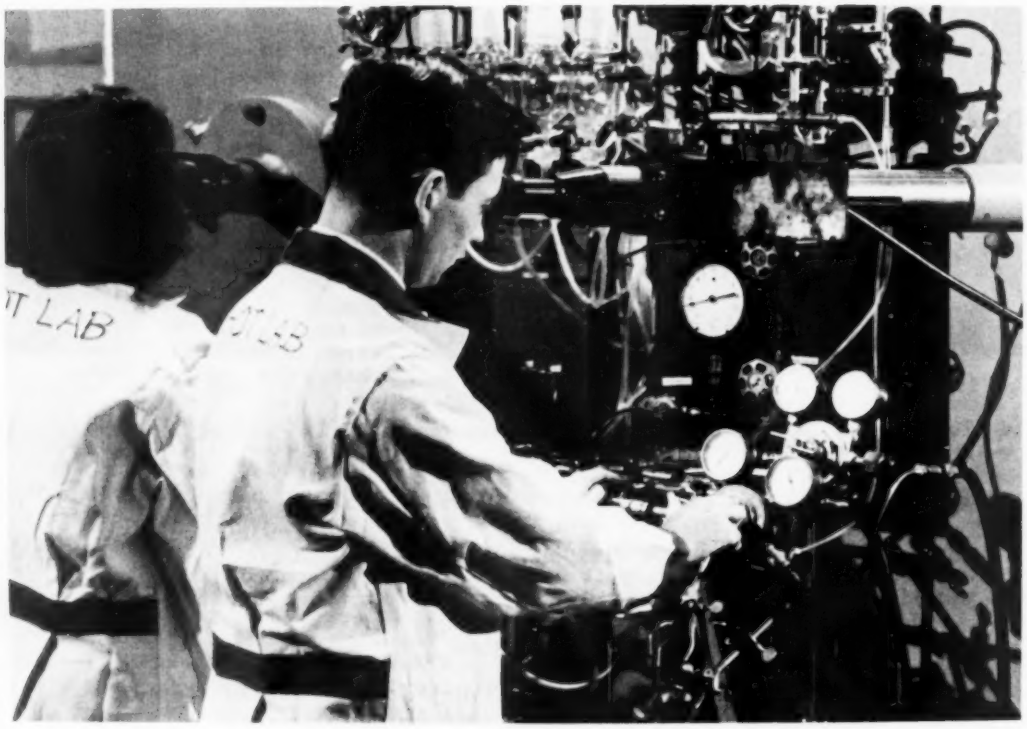
A sample survey of some 87,000 women college graduates of June 1956, conducted by the U. S. Department of

Labor's Women's Bureau in cooperation with the National Vocational Guidance Association, revealed that about 67 percent of the estimated 2,800 graduates in the biological sciences were employed 6 months after graduation; 28 percent were continuing their schooling; 3 percent were still seeking work; the remainder were neither in school nor seeking work. Of the employed biological science graduates, 51 percent were working as biological technicians; and 29 percent as teachers. The remainder were in various types of unrelated work, including clerical and sales jobs.

Of the estimated 1,500 women graduates in the physical sciences the same year, 64 percent were employed; 31 percent were attending school; 1 percent were seeking work, and only 4 percent were neither employed nor seeking work. As for those employed, 33 percent were working as chemists; 31 percent were biological technicians; 17 percent were teaching; and the remainder were engaged as mathematicians, other kinds of professional workers, and as office-workers.

Earnings of Women in Science

In most scientific fields of work, salaries for both beginning and experienced scientists have advanced rapidly in recent years. It is expected that earnings will continue to rise as long as emphasis on scientific progress continues. Typically, the more extensive the education and experience, the higher the income earned.



COURTESY OF BROOKHAVEN NATIONAL LABORATORY

Two chemists operating equipment which separates and purifies radioactive materials

In the biological sciences, an average income of $3,500 a year was reported in December 1956 by a sample group of women who had graduated in June of that year. Starting salaries were substantially higher for those who were employed in the physical sciences. These graduates averaged $4,100 a year. Some 56 percent received at least $4,000 a year; 23 percent were in the $3,500 to $3,999 range; about 12 percent earned from $3,000 to $3,499; and 10 percent earned less than $3,000 a year.

By mid-1958, the entry salary for Federal Government scientists without prior work experience was $4,490 in astronomy, chemistry, geology, meterology, and physics; and $4,040 in biology (with a few specializations at higher rates). A bonus for superior scholarship and leadership has been provided to attract more of the most promising young scientists by permitting recruitment of graduates without work experience at $4,980 a year if their college records indicate the highest job potential.

The median beginning salary for inexperienced women chemists with bachelor's degrees was about $400 a month in 1957. Average salaries of men were higher than those of women at all levels of the profession. A 1955 survey showed a considerably greater salary differential, between men and women members with long years of experience. This differential is partly due to the fact that a much smaller proportion of women chemists than men worked in private industry, which has generally higher salary levels than Federal and State Governments and research institutions. In addition, a larger proportion of women than men were in the teaching field, with its traditionally low salaries. Another factor influencing earnings is the generally lower educational attainment of women chemists.

Starting salaries for women geologists employed in private industry in 1956 were reported at $425 a month. Women with 10 years of experience averaged about $500 a month.

In the fields of physics, meteorology, and astronomy, so few women were employed that it is impossible to derive reliable average earnings or ranges of earnings.

In addition to the tangible benefits of reasonable starting salaries and possible future advancement, careers in the sciences offer most professionals a personal satisfaction in their work, a chance to learn and keep up with the latest discoveries in the field, and an opportunity to develop their highest capabilities. The scientist's own awareness that her work is useful to society is heightened by the recognition and prestige accorded by the community.

WAR BLINDED VETERANS IN A POSTWAR SETTING

This report on the physical, psychological, social, and vocational rehabilitation of a group of blinded veterans contains the findings of systematic studies made over an 11-year period by physicians, social workers, vocational training officers, and other rehabilitation workers. This comprehensive report, published by the Veterans Administration, will undoubtedly be of great value to all persons working with the blind.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price, $1.50.

RECENT CHANGES IN FEDERAL PAY RATES AND PERSONNEL PRACTICES*

In June of this year, Congress passed legislation increasing the salaries of most white-collar and professional employees in the Federal civil service and of workers in the postal service. Along with these increases, pay and promotion policies in several scientific and technical occupations were liberalized with the aim of creating salary levels above those of most Government jobs to aid in recruiting enough qualified workers. The grade levels at which college-trained personnel may be hired and the procedures for administering the Federal Service Entrance Examination were also changed. In addition, other legislation provided for training certain Federal employees at outside institutions at Government expense.

Pay Increases

The Federal Government employs about 2.3 million civilians in more than 15,000 different occupations. A 10-percent increase in salary was granted to about two-thirds of these workers, including all those paid under the Classification Act and the Postal Field Compensation Act, as well as smaller groups of workers paid under several miscellaneous acts or orders. The Classification Act determines the grades, positions, and salary scales for most clerical and professional workers in the Federal service. About 42 percent of all full-time Federal civilian employees were paid under this act in June 1957. Postal employees accounted for about 19 percent of all full-time Federal civilian employees as of the same date.

The largest group of Federal civilian employees not affected by these pay raises were skilled tradesmen and manual workers, who made up about a third of all full-time Federal employees as of June 1957. Pay scales for these "blue-collar" workers are based on the findings of wage boards regarding prevailing rates for similar area jobs in private industry and are adjusted periodically to keep pace with these rates.

An employee covered by the Classification Act normally begins at the minimum salary for his grade and receives periodic pay increases if his job performance is satisfactory. Workers holding positions in the 10 lowest grades receive salary increases every 52 weeks until the maximum salary for their grade is reached. In grades GS-11 through GS-17, increases are given every 78 weeks. The following table shows the minimum and maximum salaries for each grade of position both before and after the pay raise.

Minimum and maximum pay rates for Federal employees paid under the Classification Act -- Old rates and 1958 rates

General schedule grade	Old rates		New rates	
	Minimum	Maximum	Minimum	Maximum
1	$2,690	$3,200	$2,960	$3,530
2	2,960	3,470	3,255	3,825
3	3,175	3,685	3,495	4,065
4	3,415	3,925	3,755	4,325
5	3,670	4,480	4,040	4,940
6	4,080	4,890	4,490	5,390
7	4,525	5,335	4,980	5,880
8	4,970	5,780	5,470	6,370
9	5,440	6,250	5,985	6,885
10	5,915	6,725	6,505	7,405
11	6,390	7,465	7,030	8,230
12	7,570	8,645	8,330	9,530
13	8,990	10,065	9,890	11,090
14	10,320	11,395	11,355	12,555
15	11,610	12,690	12,770	13,970
16	12,900	13,760	14,190	15,150
17	13,975	14,835	15,375	16,335
18	16,000	16,000	17,500	17,500

Source: U.S. Civil Service Commission.

*This article brings up to date information on earnings in the Federal Government positions described in the 1957 Occupational Outlook Handbook.

The United States Civil Service Commission, Washington 25, D. C., is the best source for information about employment in the Federal Government

Because of the shortage of scientists and engineers, the Government has found it difficult to recruit workers in these categories. Before the recent pay raises, the Civil Service Commission had therefore authorized the various agencies to pay all workers in certain specified scientific and technical occupations the maximum salaries for their grades. For example, a new engineering graduate with a bachelor's degree hired to work in a Government job in 1957 would have received a starting salary of $4,480 per year, the top salary step for grade GS-5 positions --instead of $3,670 per year, the minimum salary for this grade. Then, if the engineer had been promoted to a grade GS-7 position, he would have been paid $5,335 per year, the maximum for grade GS-7 before the new salary schedule became effective.

This arrangement was modified when the new pay raises took effect. If the same engineer were to be hired now, he would be paid a starting salary of $4,490 per annum--the 4th of the 7 pay rates for grade GS-5 and the lowest one which is as high as the maximum salary for this grade before the pay raise. If he were promoted to grade GS-7 now, he would be paid $5,430, again the 4th pay rate for the grade and the lowest one which represents a salary as high as the previous maximum for the grade. Thus, although scientific and technical workers will no longer be paid starting salaries at the top rate of their grades, they will still be paid more than the usual begin-

ning salaries for these grades. Following are the occupational categories for which above-minimum salaries were authorized by the Civil Service Commission on a nationwide basis as of June 20, 1958:

GS-1350	Geology
GS-800	All professional engineering series
GS-1312	Electronic research, develop and test
GS-1310	Physics
GS-1320	Chemistry
GS-1321	Metallurgy
GS-1330	Astronomy
GS-1520	Mathematics
GS-1530	Mathematical statistics
GS-1040	Architecture
GS-1221	Patent adviser
GS-602	Medical officer
GS-700	Professional veterinarians
GS-454	Range management and conservation
GS-1041	Landscape architecture
GS-1313	Geophysical exploration, survey, and investigation
GS-1360	Oceanography (physical)
GS-1390	Technology
GS-1301	Physical science administration
GS-405	Pharmacology
GS-1340	Meteorology
GS-1220,	1222, 1223, 1224, 1225 Professional patent positions in the Patent Office
GS-460	Forestry
GS-470	Soil science
GS-015	Operations research

In certain local areas, above-minimum salaries have been authorized for workers in a number of other occupations including card-punch operators on the West Coast, engineering aids in California, and actuaries in Baltimore and other cities.

New Entry Grade Regulations for Some Professional Personnel

Another recent change in Civil Service regulations provides that, in some cases, agencies may hire outstanding college graduates with bachelor's degrees for beginning jobs at grade GS-7.[1] The former grade for such beginning appointments was fixed at GS-5, which is still the normal professional entrance grade.

Entrance Examinations

Changes have also been made in the general Federal Service Entrance Examination (FSEE) which has been used since 1955 to recruit college-caliber people for a wide range of Government positions. This examination will be open from the fall of one year into the spring of the following year, with written tests scheduled several times during this period. Dates of the tests, which are open to college juniors as well as seniors, will be announced each fall by the U. S. Civil Service Commission.

Under the new plan, applicants who pass the examination during the 1958-59 school year will be placed on an eligible list. They will remain eligible for appointment only until a new list of eligibles is established during the next school year. Thus, to remain eligible for appointment, applicants must take and pass the examination each year.

Under the old plan, more than 60,000 persons had passed the written test and established their eligibility for appointment to Federal positions. Persons in this group who have not received appointments before the fall of 1958 should plan to take one of the new examinations if they are still interested in entering the Federal service.

Some agencies offer a limited number of management internships. Such agencies have specially planned programs designed to develop persons with unusual promise as future administrators. Persons to be considered for these internships will be required to pass additional tests of greater difficulty. Those selected for these programs will receive specialized instruction, varied work assignments, and understudy or other types of training designed to develop their managerial skills and knowledge.

[1] See Careers for Women Scientists, p. 20.

The FSEE will continue to be used to recruit college-caliber people for management internships, but the special additional tests for these positions will be given less often than in the past. Thus, it will be advisable for applicants to file for these tests early in the academic year. The interviews conducted as part of the selection process will be held during the late winter or early spring so that successful candidates selected for appointment will be able to enter on duty soon after graduation.

Employee Training Programs

The new Government Employees Training Act, signed into law by the President on July 7, 1958, provides the first governmentwide authority for training of employees within their own agencies, in other Federal establishments, and in non-Federal facilities such as colleges, universities, manufacturing plants, and laboratories. The chief highlight of the new law is that agencies can now pay for training of employees in nongovernmental facilities. Agency heads are responsible for determining the kinds of training to be given, when and where it is to be given, which employees need training, and how much money to allot for training purposes within the limits of their appropriations. The number of trainees in any agency may not exceed 1 percent of its authorized personnel strength.

Trainees must agree in advance either to remain with the agency for at least three times the length of the training period or to repay the training costs. Employees must have at least 1 year of continuous service before they can be given any outservice training, and may receive only 1 year of outservice training for each 10 years of total service. Such training is to be given employees only when necessary to satisfy an agency's personnel needs; it may not be given solely for the purpose of promoting employees or helping them obtain academic degrees.

For more detailed information on training opportunities, write the U. S. Civil Service Commission, Washington 25, D. C.

MATHEMATICS AND YOUR CAREER

This 12-page, illustrated pamphlet emphasizes the importance of mathematics to successful careers in many fields of work. It is directed primarily to high school students.

The pamphlet lists about 75 occupations requiring a knowledge of mathematics, and indicates the amount needed for these occupations. It also lists sources of additional information.

Single copies of the pamphlet are available as long as the supply lasts. Requests should be addressed to the Occupational Outlook Service, Bureau of Labor Statistics, U. S. Department of Labor, Washington 25, D.C.

EMPLOYMENT OUTLOOK FOR STATIONARY ENGINEERS*

by Ian R. Sutherland

The man in charge of the heating equipment in a large school is likely to be a member of one of the larger skilled occupations in the United States--stationary engineer. These workers are needed wherever large boilers, diesel and steam engines, refrigeration and air-conditioning machinery, electric generators, motors, and turbines are used. They work in such places as factories, power stations, mines, sewage plants, office buildings, hotels, hospitals, apartment buildings, and schools.

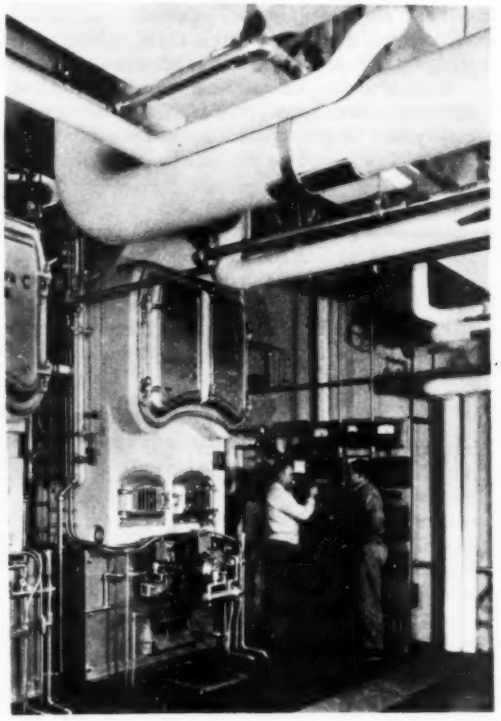
Nature of Work

The stationary engineer operates and maintains all the different kinds of equipment used to generate power and to heat, ventilate, and air condition large buildings and other structures. He carries a heavy responsibility for he must know how to operate the equipment in conformance with safety regulations, and how to keep it in good working order.

To make sure that everything is working properly, the stationary engineer inspects the equipment regularly each day. He reads meters, gages, and other instruments, and records such information as amount of fuel used, temperature of boilers, number of pieces of equipment in use, hours of operation, and repairs made. He must be able to detect and identify trouble that develops by analyzing the various readings and watching and listening to the machinery. He uses levers, throttles, switches, valves, and other devices to regulate and control the machinery so as to achieve maximum efficiency.

Stationary engineers also may repair the equipment they operate, using handtools such as wrenches and hammers. The replacing of worn valves and gaskets are common repair jobs performed by these workers. Some stationary engineers may sometimes make mechanical changes in their equipment or construct special attachments so that the machinery will operate more efficiently.

The particular job duties of stationary engineers depend to a considerable extent on the size of estab-



Stationary engineer and assistant read fuel combustion gage on boiler control panel

*This article is one of a series of reports on fields of work which could not be covered in the 1957 edition of the Occupational Outlook Handbook. It is part of the Bureau's continuing program of occupational outlook research.

lishment in which they work and the type and size of machinery for which they are responsible. For example, in small plants, the engineer himself may oil and clean the equipment, clean boiler tubes and walls, and grease moving parts. In large plants, he may supervise other stationary engineers or such workers as turbine operators, firemen, and oilers in the operation and maintenance of equipment. Stationary engineers employed in small plants are usually responsible for all types of machinery and equipment; in some very large plants, they may be in charge of only one type of machinery or operation.

Where Employed

About 200,000 stationary engineers were employed in mid-1958. Most of these men worked in private industry, though more than 30,000 were employed by Federal, State, and local governments.

The type of establishment in which the engineers worked ranged from giant hydroelectric plants and large public buildings to small industrial plants. While staffs of stationary engineers may range anywhere from 1 to more than 60 on all shifts, most plants employ from 3 to 8 engineers. In some establishments, only one engineer is at work on each shift.

Because stationary engineers work in so many different kinds of establishments and industries, they are employed in all parts of the country. Although some are employed in small towns and in rural areas, most work in the more heavily populated areas where large industrial and commercial establishments are located. New York, Pennsylvania, Illinois, Texas, California, and Ohio are leading States in the employment of these workers.

Training, Other Qualifications, and Advancement

To be hired as a stationary engineer in almost any large or medium-sized city, the applicant must have a license which permits him to do this work. Most of these licenses are issued by cities and counties; a few States also require stationary engineers to be licensed. However, in many smaller cities and rural areas licenses may not be required for this work even though the job qualifications may be just as strict as those where licenses are required.

Although license requirements differ from place to place, the following are common: (1) The applicant must be over 21 years of age; (2) he must have resided in the State or locality in which the examination is given for a specified period of time; (3) he must demonstrate that he meets the experience requirements for the class of license requested; and (4) he must pass an examination, which may be written, oral, or a combination of both.

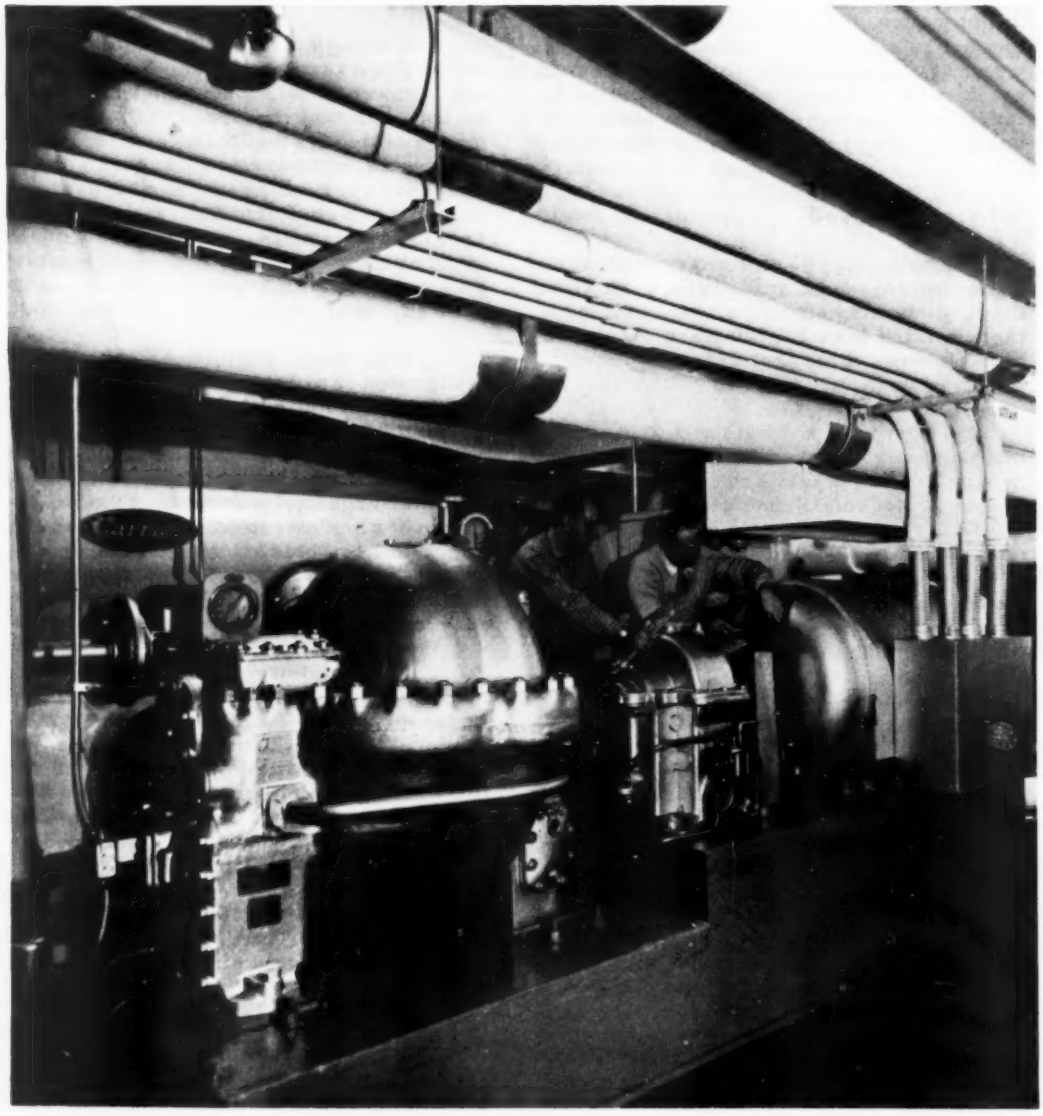
Stationary engineer licenses are designated as 1st class, 2d class, or 3d class. Stationary engineers with 2d and 3d class licenses are permitted to operate only the smaller equipment independently. However, they may operate large equipment under the supervision of a higher rated engineer--usually one with a 1st class license. Generally, under 1st class licenses, no restriction is placed on the equipment the engineer may operate.

The majority of stationary engineers now working in this field started as helpers and acquired their skills largely through informal on-the-job experience. However, because of the increasing complexity of stationary machinery and the varied training and experience required for a license today, formal apprenticeship training for this occupation, which is now available in many areas, is a good way to qualify. After completing apprenticeship, a journeyman stationary engineer must usually get further work experience before he can qualify for a 1st class license.

In selecting apprentices, employers generally prefer young men between 18 and 23 years of age with a high school or trade school education, including courses in such subjects as algebra, geometry,

trigonometry, shop mathematics, mechanical drawing, machine-shop practice, physics, and chemistry. Employers also desire young men with mechanical aptitude and manual dexterity.

A stationary engineering apprenticeship usually lasts 4 years. Through on-the-job training, the apprentice learns to operate, maintain, and repair equipment such as blowers, generators, compressors, boilers, motors, and air-conditioning and refrigeration machinery. He is taught how to use hand and machine tools, such as chisels, hammers, electric grinders, lathes, drill presses, and such



A large 300-ton air-conditioning compressor is given a routine inspection

measuring instruments as calipers and micrometers. In addition, he may be taught how to use blocks, chain hoists, and other equipment used to move machinery. He must supplement this on-the-job training by instruction in such related technical subjects as practical chemistry, elementary physics, blueprint reading, applied electricity, and theory of refrigeration, air-conditioning, ventilation, and heating.

Persons who become stationary engineers without going through a formal apprenticeship program usually do so only after years of experience as assistants to licensed stationary engineers in such occupations as boiler, refrigeration, or turbine operator. This practical experience usually must be supplemented by vocational or other school training, or home study.

Holders of 2d and 3d class licenses may obtain higher grade licenses and thus prepare themselves for advancement in the occupation by satisfying experience requirements and passing an examination. This advancement, however, is not automatic since a 1st-class stationary engineer may work for some time as an assistant to another 1st class engineer before a vacancy occurs. Another way an engineer may advance is by obtaining a job in a plant where he is responsible for larger or more diverse equipment. A few stationary engineers may be promoted to jobs as plant engineers and building and plant superintendents. In general, the broader the knowledge a stationary engineer has about the design, operation, maintenance, and repair of various types of equipment, the better are his chances for advancement.

Employment Outlook

A moderate increase in employment of stationary engineers is expected during the 1960's. In addition, about 5,000 opportunities for new workers to enter this large field of employment will occur each year because of the need to replace workers who retire or die. Transfers out of this occupation to other fields of work will also be a source of job openings for new workers.

The continuing increase in the use of large stationary boilers, refrigeration, and air-conditioning equipment in the Nation's factories, powerplants, and commercial buildings is the primary factor indicating an increase in employment in this occupation. However, improved operating efficiency resulting from the use of larger and more centralized equipment and better utilization of manpower may limit somewhat the growth in the employment of stationary engineers.

The increasing use of atomic energy should not affect significantly the employment of stationary engineers. It is probable that both the number and skill requirements of operating jobs (i.e., stationary engineer, boiler operator, turbine operator, etc.) in a nuclear plant will be about the same as those in a new conventional powerplant.

Earnings and Working Conditions

Average hourly earnings of stationary engineers in many large cities in early 1958 ranged from $1.90 to $2.85 an hour. Generally, the lower wage rates were paid in the South. However, there were exceptions; for example, stationary engineers in Birmingham had higher average earnings than those in Philadelphia in early 1958. Stationary engineers who have supervisory responsibilities may earn considerably more than the average; some of these workers in large establishments earn more than $150 a week.

Stationary engineers generally enjoy steady year-round employment. They usually work a straight 8-hour day with a workweek ranging from 40 to 48 hours. In plants or institutions which operate around the clock, stationary engineers may be assigned to any 1 of 3 shifts--often on a rotating basis--and to Sunday and holiday work.

Many stationary engineers are employed in plants which have labor-

management contracts, most of which provide benefits which may include hospitalization, medical and surgical insurance, life insurance, sickness and accident insurance, and retirement pensions. Similar benefits may also be provided in plants in which labor-management contracts have not been negotiated.

Although most of the engine rooms, powerplants, or boiler rooms where stationary engineers work are clean and well lighted, this is by no means true in every case. Even under the most favorable conditions, some stationary engineers are exposed to high temperatures, dust, dirt, contact with oil and grease, and odors from oil, gas, coal, or smoke. In repair or maintenance work, they may have to crawl inside a boiler and work in a crouching or kneeling position to clean or repair the interior.

Because stationary engineers often work around boilers, electrical and mechanical equipment, they must be alert to avoid burns, electrical shock, and injury from moving machinery. If the equipment is not operated correctly or if it is defective, it may be dangerous to them as well as to other persons in the vicinity. However, modern equipment and safety procedures have reduced accidents greatly.

Many stationary engineers belong to unions. Among the unions to which these workers belong are the International Union of Operating Engineers, and the International Union, United Automobile, Aircraft & Agricultural Implement Workers of America.

GRANTS AVAILABLE TO HIGH SCHOOL TEACHERS OF SCIENCE AND MATHEMATICS

About 3,000 high school teachers of science and mathematics will have an opportunity, during 1958-59, to receive in-service training at institutes supported by grants from the National Science Foundation.

Approximately 85 colleges and universities throughout the United States will conduct in-service institutes which offer science and mathematics courses especially designed for teachers of these subjects. Institute meetings are scheduled so that teachers may attend them while teaching full time in their schools. Travel expenses, tuition, and fees of participating teachers will be covered by the National Science Foundation grants.

A list of the institutions at which grants are available may be obtained from the National Science Foundation, Washington 25, D.C.

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